IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF NEBRASKA

SAPREX, LLC, Plaintiff, v. LINCOLN INDUSTRIES, INC., Defendant.	Case No. 20-338 **COMPLAINT** **JURY TRIAL DEMANDED**

Plaintiff SAPREX, LLC ("Saprex" or "Plaintiff") brings this action pursuant to 35 U.S.C. § 1 *et seq*. seeking injunctive relief and damages against Defendant LINCOLN INDUSTRIES, INC. ("Lincoln" or "Defendant") for patent infringement, and alleges as follows:

NATURE OF THE SUIT

1. This is a civil action for patent infringement of United States Patent No. 10,591,104 ("the '104 Patent") under 35 U.S.C. § 271 *et seq*.

PARTIES

2. Plaintiff is a limited liability company organized under the laws of the State of North Carolina, having a principal place of business at 5631 Gallagher Drive, Gastonia, North Carolina 28052.

3. On information and belief, Defendant is a corporation organized under the laws of the State of Nebraska, having a place of business at 600 West E Street, Lincoln, Nebraska 68522.

JURISDICTION AND VENUE

3. This Court has subject matter jurisdiction over this action pursuant to 28 U.S.C. §§ 1331 and 1338(a) because this action arises under the patent laws of the United States.

4. On information and belief, Defendant resides in this State and District.

5. On information and belief, Defendant has regularly and intentionally conducted business in this State and District, and is subject to personal jurisdiction in this State and District by virtue of its contacts here.

6. Moreover, this Court has personal jurisdiction over Defendant at least because Plaintiff's claim arises in whole or part from Defendant's conduct in this District, including acts of patent infringement as alleged herein. Additionally, this Court has personal jurisdiction over Defendant because Defendant is organized under the laws of the State of Nebraska, and maintains and has maintained continuous and systematic contacts, including its principal place of business, within this District.

7. On information and belief, Defendant has purposefully and intentionally made, used, sold, and offered for sale infringing ThermoLinc® Elite exhaust insulation systems in this District.

8. Venue is proper in this Court pursuant to 28 U.S.C. §§ 1391 and 1400 pursuant to *TC Heartland LLC v. Kraft Foods Group Grands LLC*, 137 S.Ct. 1514 (2017), at least because Defendant resides in this District, has or has had a regular and established place of business in this District, and has committed acts of infringement in this District.

PLAINTIFF AND ITS PATENT RIGHTS

9. Plaintiff specializes in advancing materials exposed to extreme environments, including fire, high heat, cut and chemical. Plaintiff conceives and develops material solutions for partners with unique environmental challenges. Plaintiff's material expertise includes fiber, fabric, and reinforced composite systems.

10. Among Plaintiff's products is an advanced high temperature composite pipe insulation system sold under the name Axiom, which is described on Plaintiff's website at http://saprex.com/axiom as follows:

> Saprex Axiom is a highly customizable, composite based insulation system for pipes, which contains insulation layers, a composite cover and a highly modifiable resin system. This mass-customizable system can be easily adapted for pipes that carry fluids from sub-freezing to over 2000°F internal pipe temperatures, and can be modified in both aesthetic and functional characteristics. Similar to pulling on your socks, this system is easy to slip on and is very flexible. After installation, the entire assembly is heated to cure the composite based cover, which completes the process.
>
> Because of its highly flexible nature, this system will conform to just about any pipe geometry and allows for variable insulation along the pipe, if desired. As an added benefit, this system's high degree of conformability will allow you to carry less inventory.

11. Another one of Plaintiff's products is a high temperature composite pipe insulation system sold under the name Axis, which is described on Plaintiff's website http://saprex.com/axis as follows:

> Saprex Axis is an easy to install, self-molding composite based insulation system for pipes. This unique system can be easily customized for pipes that carry fluids from sub-freezing to over 2000F internal pipe temperatures. Similar to pulling on your socks, this system is easy to install and very flexible. After installation, the entire assembly is heated to cure the composite based cover, which completes the process. Because of its highly flexible nature, this system will conform to just about any pipe geometry and allows for variable insulation along the pipe, if desired. As an added benefit, this system's high degree of conformability will allow you to carry less inventory.
>
> Axis is not only breathable and tough, but also resilient. This system has the ability to handle pipe temperatures above 2000F, as well as the structural integrity to withstand the rigors of water, salt and general wear, overtime.

12. Yet another one of Plaintiff's products is a biaxial composite system for pipes sold under the name Biax, which is described on Plaintiff's website at http://saprex.com/biax as follows:

> Biax is a single layer insulation cover. This economical cover is a cost effective alternative to end users without access to a curing oven. Available in multiple colors and functional additives, BIAX takes easy insulation installation to a new level.

13. Plaintiff is one of the few manufacturers of exhaust insulation systems in the United States.

14. Plaintiff is the owner of all right, title, and interest in and to the ’104 Patent entitled “Breathable Multi-Component Exhaust Insulation System.” A true and correct copy of the ’104 Patent is attached hereto at Exhibit 1.

15. The application of the ’104 Patent (U.S. Pat. App. No. 16/413,520) published as U.S. Publication No. 2019/0264858 (the “’858 Publication”) on August 29, 2019.

16. The claims found in the ’858 Publication did not change between the publication date and the issuance of the ’104 Patent.

17. The ’104 Patent was duly and lawfully issued by the United States Patent and Trademark Office on March 17, 2020. The ’104 Patent and all of its claims are presumed valid pursuant to 35 U.S.C. § 282.

18. Plaintiff is the owner, by assignment, of the ’104 Patent.

19. The claims of the ’104 Patent are generally directed to an exhaust insulation sleeve for an exhaust pipe.

20. For example, Claim 1 of the ’104 Patent states:

> 1. A breathable, multi-component exhaust insulation sleeve for an exhaust pipe, said insulation sleeve comprising:
>
> an inner layer comprising a first fabric made from a first high-temperature resistant material forming a sleeve, wherein said sleeve is configured to be positioned adjacent to and disposed about an outer surface of a section of the exhaust pipe; and
>
> an outer cover layer comprising heat cured polymeric resin and a second fabric including yarns comprising glass fibers, wherein the outer cover layer is positioned adjacent to and disposed over the inner layer, wherein the yarns are fused together, wherein the fused yarns dimensionally stabilize and stiffen the outer cover layer around the inner layer.

21. As another example, Claim 2 of the ’104 Patent states:

> The insulation sleeve set forth in claim 1, wherein said inner layer is made from material selected from the group consisting of e-glass, s-glass, silica, basalt and ceramic.

22. As a further example, Claim 5 of the ’104 Patent states:

> The insulation sleeve set forth in claim 1, further including at least one middle layer disposed between said inner layer and said outer layer.

DEFENDANT’S INFRINGING SYSTEM

23. On information and belief, Defendant is engaged in the business of making, using, selling, offering for sale in the United States, and/or importing into the United States, exhaust insulation systems, including Defendant’s ThermoLinc® Elite exhaust insulation system.

24. Defendant’s ThermoLinc® Elite exhaust insulation system is offered as a heat management solution with heat mitigation and insulation properties, as described on Defendant’s website at https://www.lincolnindustries.com/what-we-do/we-deliver-technology/thermolincr:

Heat management solutions

ThermoLinc® technologies solve many thermodynamic challenges. Each proprietary technology uses unique material combinations that provide unmatched solutions in heat mitigation, insulation, reduction of surface temperatures and more.These technologies are currently used for high heat applications in heavy-duty truck, motorcycle and UTV/ATV.

Lincoln Industries offers extensive lab testing per ASTM standards and OEM specifications. Specialized engineers can provide customizable solutions for any heat management challenges.

ThermoLinc® Technologies	
ThermoLinc® Genesis PDF	Thermal insulating coating that can be used for applications up to 400° currently used in EGR applications for automotive.
ThermoLinc® Elite PDF	Textile insulation for diesel and gas exhaust applications up to 1800°F.
ThermoLinc® Frontline	Thermal barrier textile pad.
ThermoLinc® Escape	High emissivity coating that can reach up to 1400°F.
ThermoSox® PDF	Thermal insulating sleeve for tube up to 1112°F.

25. The pdf linked to the ThermoLinc® Elite product found at https://www.lincolnindustries.com/sites/default/files/_images/content/thermolinc_elite_web.pdf explains that "ThermoLinc® Elite is a multilayer textile solution that solves a variety of heat management challenges in both diesel and gas exhaust engines" and that its "Textile cover provides durable outer layer." (Exhibit 2, p. 1). This document further states that the product has "insulation" (i.e. an inner layer) and that its outer layer is a "thermoset glass braid cover." (Exhibit 2, p. 2). According to this document, the ThermoLinc® Elite product performs "up to 950ºC (1742ºF) . . . and offers significant surface temperature reduction." (Exhibit 2, p. 1). The ThermoLinc® Elite product is depicted as follows:

(Exhibit 2, p. 1).

26. After learning about the Defendant's ThermoLinc® Elite product, Plaintiff sent a letter on September 20, 2019 to Defendant, explaining that its product was covered by the claims published in the '858 Publication.

27. In a letter dated January 22, 2020, Defendant responded, acknowledging the existence of the '858 Publication and noted that its outer cover includes a polymeric resin and braided glass.

28. Defendant continues to offer for sale its ThermoLinc® Elite product despite notice of its product being covered by the '858 Publication claims and despite the issuance of the '104 Patent with identical claims to the '858 Publication.

29. On information and belief, Defendant's ThermoLinc® Elite exhaust insulation system comprises a breathable, multi-component exhaust insulation sleeve for an exhaust pipe, said insulation sleeve comprising an inner layer comprising a first fabric made from a first high-temperature resistant material forming a sleeve, wherein said sleeve is configured to be positioned adjacent to and disposed about an outer surface of a section of the exhaust pipe; and an outer cover layer comprising heat cured polymeric resin and a second fabric including yarns

comprising glass fibers, wherein the outer cover layer is positioned adjacent to and disposed over the inner layer, wherein the yarns are fused together, wherein the fused yarns dimensionally stabilize and stiffen the outer cover layer around the inner layer.

30. On information and belief, Defendant's ThermoLinc® Elite exhaust insulation system further comprises an inner layer made from material selected from the group consisting of e-glass, s-glass, silica, basalt and ceramic.

31. On information and belief, Defendant's ThermoLinc® Elite exhaust insulation system further includes at least one middle layer disposed between the inner layer and the outer layer.

32. On information and belief, Defendant's ThermoLinc® Elite exhaust insulation system also meets the limitations of additional dependent claims as found in the '104 Patent.

CLAIM I
INFRINGEMENT OF U.S. PATENT NO. 10,591,104

33. Plaintiff realleges and incorporates by reference the foregoing paragraphs.

34. Plaintiff is the owner by assignment of all rights, title, and interest in and to the '104 Patent.

35. Defendant has directly infringed and continues to directly infringe at least Claims 1, 2, and 5 of the '104 Patent, in violation of 35 U.S.C. § 271(a), either literally or equivalently, by making, using, selling, offering for sale, and/or importing into the United States infringing exhaust insulation sleeves for exhaust pipes, namely the Defendant's ThermoLinc® Elite exhaust insulation system.

36. Defendant has actively induced infringement and continues to actively induce infringement under at least Claims 1, 2, and 5 of the '104 Patent, in violation of 35 U.S.C. § 271(b), by selling its ThermoLinc® Elite exhaust insulation system to vehicle manufacturers or

their suppliers, intending it to be used by these parties as specified by Defendant, which parties then incorporate the infringing product into vehicles that are sold to consumers or end users.

37. Defendant has committed the acts of infringement complained of herein without the consent or authorization of Plaintiff and in derogation of 35 U.S.C. § 271.

38. Defendant has harmed and continues to harm Plaintiff by virtue of Defendant's acts of infringement of the '104 Patent.

39. Defendant has harmed and continues to harm Plaintiff by virtue of Defendant's acts of induced infringement of the '104 Patent.

40. Defendant's acts of infringement will continue unabated, continue to cause Plaintiff irreparable harm, unless and until enjoined by this Court.

41. Defendant has had actual notice of the '858 Publication and its claims since at least as early as September 20, 2019, when Plaintiff sent Defendant a letter regarding the '858 Publication and claims of the eventual '104 Patent.

42. Defendant responded to Plaintiff's letter on January 22, 2020, acknowledging it had reviewed the '858 Publication and file history.

43. Defendant has knowledge of the issuance of the '104 Patent, at least as early as the filing of this Complaint and, on information and belief, since the issuance of the '104 Patent.

44. On information and belief, Defendant made, used, offered for sale, sold or imported in the United States its ThermoLinc® Elite product, which encompasses the invention as claimed in the '858 Publication prior to the issuance of the '104 Patent.

45. On information and belief, Defendant has continued to make, use, offer for sale, sell or import in the United States its ThermoLinc® Elite product after the issuance '104 Patent.

46. The claims of the '858 Publication and the '104 Patent are identical.

47. Plaintiff's provisional rights in the '104 Patent have been harmed by Defendant's unlawful actions since the publication of the '858 Publication.

48. On information and belief, Defendant's infringement of the '104 Patent has been intentional and willful, since before the filing of this Complaint.

49. On information and belief, Defendant's infringement of Plaintiff's provisional rights in the '104 Patent has been intentional and willful, since at least September 20, 2019.

50. Plaintiff is entitled to damages from Defendant pursuant to 35 U.S.C. § 284, including treble damages, damages pursuant to 35 U.S.C. § 285, and injunctive relief from this Court pursuant to 35 U.S.C. § 283.

51. Plaintiff is entitled to damages from Defendant pursuant to 35 U.S.C. § 154 for Defendant's violation of Plaintiff's provisional rights in the '104 Patent.

WHEREFORE, Plaintiff prays for the entry of a judgment:

A. Holding that Defendant has infringed the '104 Patent;

B. Awarding Plaintiff damages adequate to compensate for all such unauthorized acts of infringement of Plaintiff's provisional rights pursuant to 35 U.S.C. § 154.

C. Awarding Plaintiff damages adequate to compensate for all such unauthorized acts of infringement pursuant to 35 U.S.C. § 284;

D. Declaring this case as exceptional pursuant to 35 U.S.C. § 285;

E. Awarding Plaintiff pre- and post-judgment interest to the extent permitted by law;

F. Permanently enjoining Defendant from any further acts of infringement of Plaintiff's patent rights pursuant to 35 U.S.C. § 283; and

G. Awarding such other and further relief as this Court may deem just and proper.

Plaintiff demands a trial by jury on all issues so triable.

Date: August 21, 2020

Respectfully submitted,

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Attorneys for Plaintiff, SAPREX, LLC

Exhibit 1

US010591104B2

(12) **United States Patent**
Goulet

(10) **Patent No.: US 10,591,104 B2**
(45) **Date of Patent: *Mar. 17, 2020**

(54) **BREATHABLE MULTI-COMPONENT EXHAUST INSULATION SYSTEM**

(71) Applicant: **SAPREX, LLC**, Gastonia, NC (US)

(72) Inventor: **Robert Jacque Goulet**, Gastonia, NC (US)

(73) Assignee: **Saprex, LLC**, Gastonia, NC (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/413,520**

(22) Filed: **May 15, 2019**

(65) **Prior Publication Data**

US 2019/0264858 A1 Aug. 29, 2019

Related U.S. Application Data

(63) Continuation of application No. 15/985,135, filed on May 21, 2018, now Pat. No. 10,295,109, which is a (Continued)

(51) **Int. Cl.**
F16L 59/02 (2006.01)
F01N 13/14 (2010.01)
(Continued)

(52) **U.S. Cl.**
CPC ***F16L 59/029*** (2013.01); ***B32B 1/08*** (2013.01); ***B32B 5/08*** (2013.01); ***B32B 5/22*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC F01N 13/14; F01N 13/148; F01N 13/1805; F01N 13/1811; F01N 13/1816;
(Continued)

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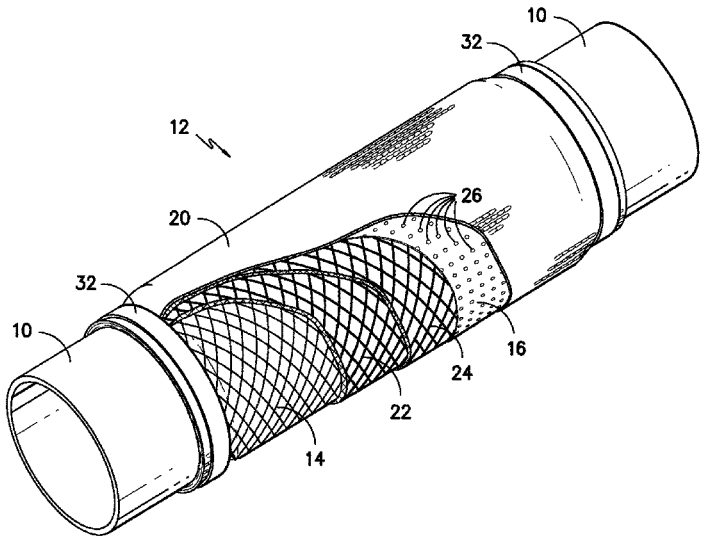
(Continued)

Primary Examiner — J C Jacyna
(74) *Attorney, Agent, or Firm* — Moore & Van Allen PLLC; Henry B. Ward, III

(57) **ABSTRACT**

A breathable, multi-layer exhaust insulation system is provided. The system includes a multi-layer sleeve, wherein the first layer, which is positioned adjacent the exhaust system pipes, is a braided sleeve which may be constructed from high-temperature resistant materials such as e-glass, s-glass, silica or ceramic. Additional braided layers of material may be included, as well. An outside cover of material is preferably a circular knitted fabric that contains glass fibers and resin-based fibers. The knitted fabric forms a tube on the outside of the insulating layers, and may be formed from a core spun yarn, which includes a glass filament core and a high-melt fiber on the wrap. Optionally, the system may also include a perforated or unperforated metal foil layer and/or a tape wrap, and the various components may be configured as desired.

20 Claims, 6 Drawing Sheets



Related U.S. Application Data

continuation-in-part of application No. 13/475,501, filed on May 18, 2012, now Pat. No. 9,976,687.

(51) **Int. Cl.**

F01N 13/18	(2010.01)
D04B 1/14	(2006.01)
F16L 59/08	(2006.01)
B32B 5/08	(2006.01)
B32B 5/22	(2006.01)
B32B 5/26	(2006.01)
B32B 1/08	(2006.01)

(52) **U.S. Cl.**

CPC ***B32B 5/26*** (2013.01); ***D04B 1/14*** (2013.01); ***F01N 13/148*** (2013.01); ***F01N 13/1816*** (2013.01); ***F16L 59/08*** (2013.01); *B32B 2250/02* (2013.01); *B32B 2250/03* (2013.01); *B32B 2250/04* (2013.01); *B32B 2250/20* (2013.01); *B32B 2262/0261* (2013.01); *B32B 2262/0269* (2013.01); *B32B 2262/0276* (2013.01); *B32B 2262/101* (2013.01); *B32B 2262/105* (2013.01); *B32B 2262/14* (2013.01); *B32B 2307/304* (2013.01); *B32B 2307/306* (2013.01); *B32B 2597/00* (2013.01); *D10B 2505/12* (2013.01)

(58) **Field of Classification Search**

CPC F16L 59/08; F16L 59/029; D04B 1/14; D10B 2505/12

See application file for complete search history.

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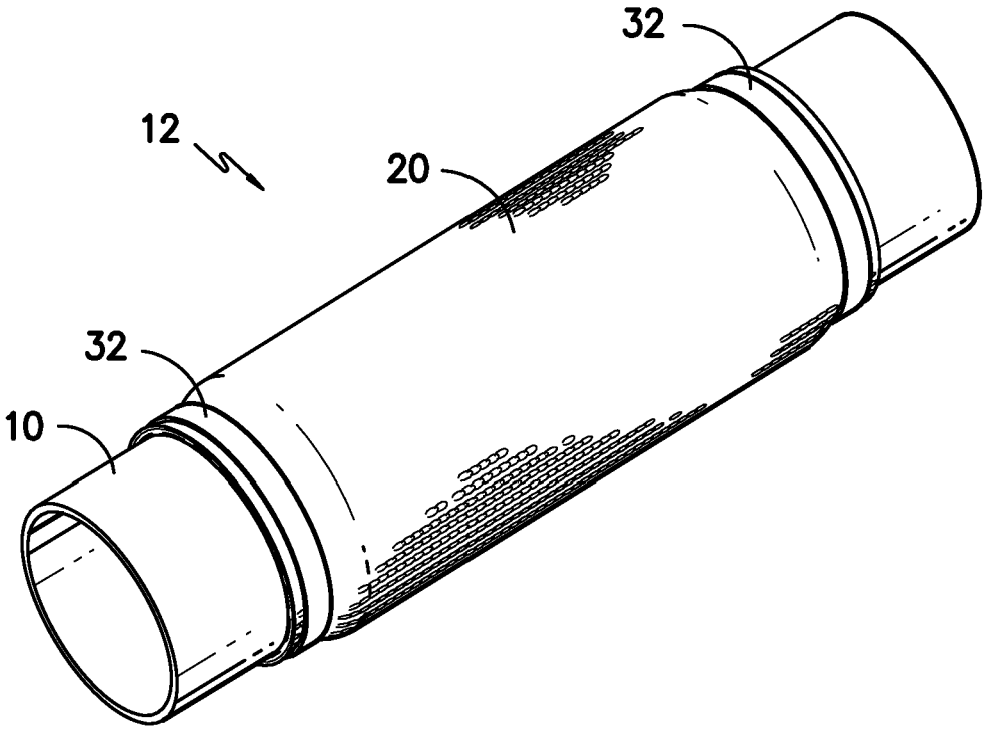


FIG. 1

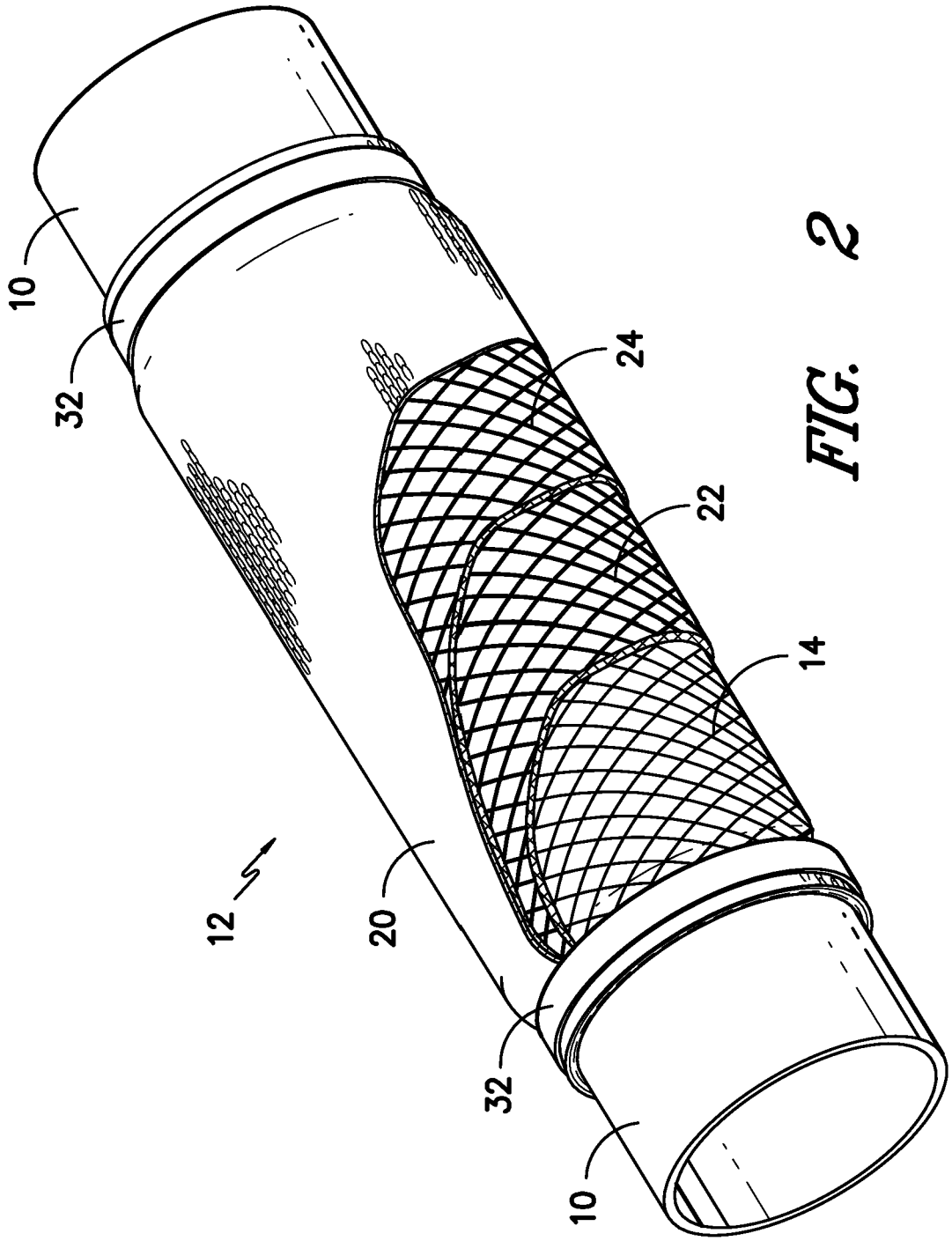


FIG. 2

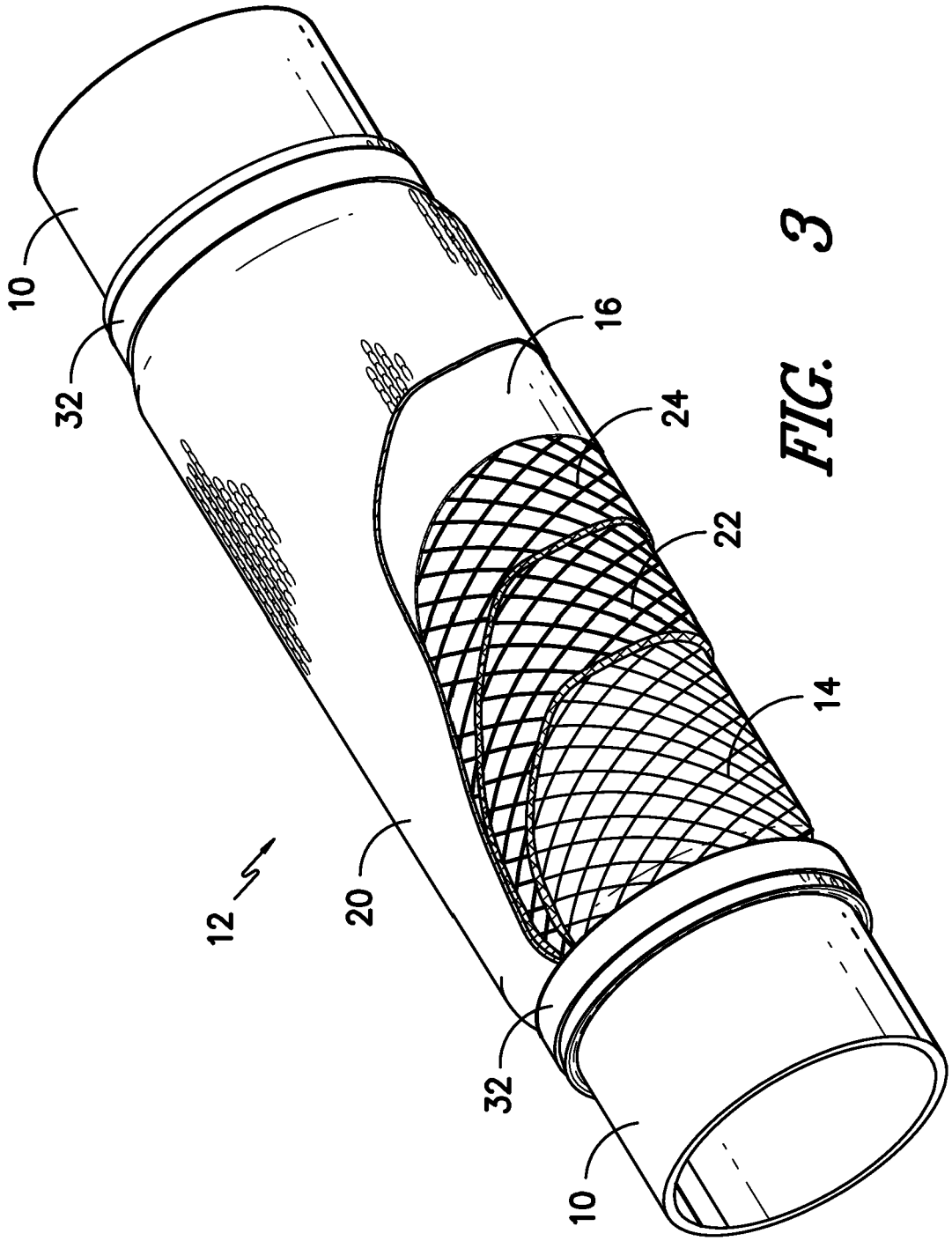


FIG. 3

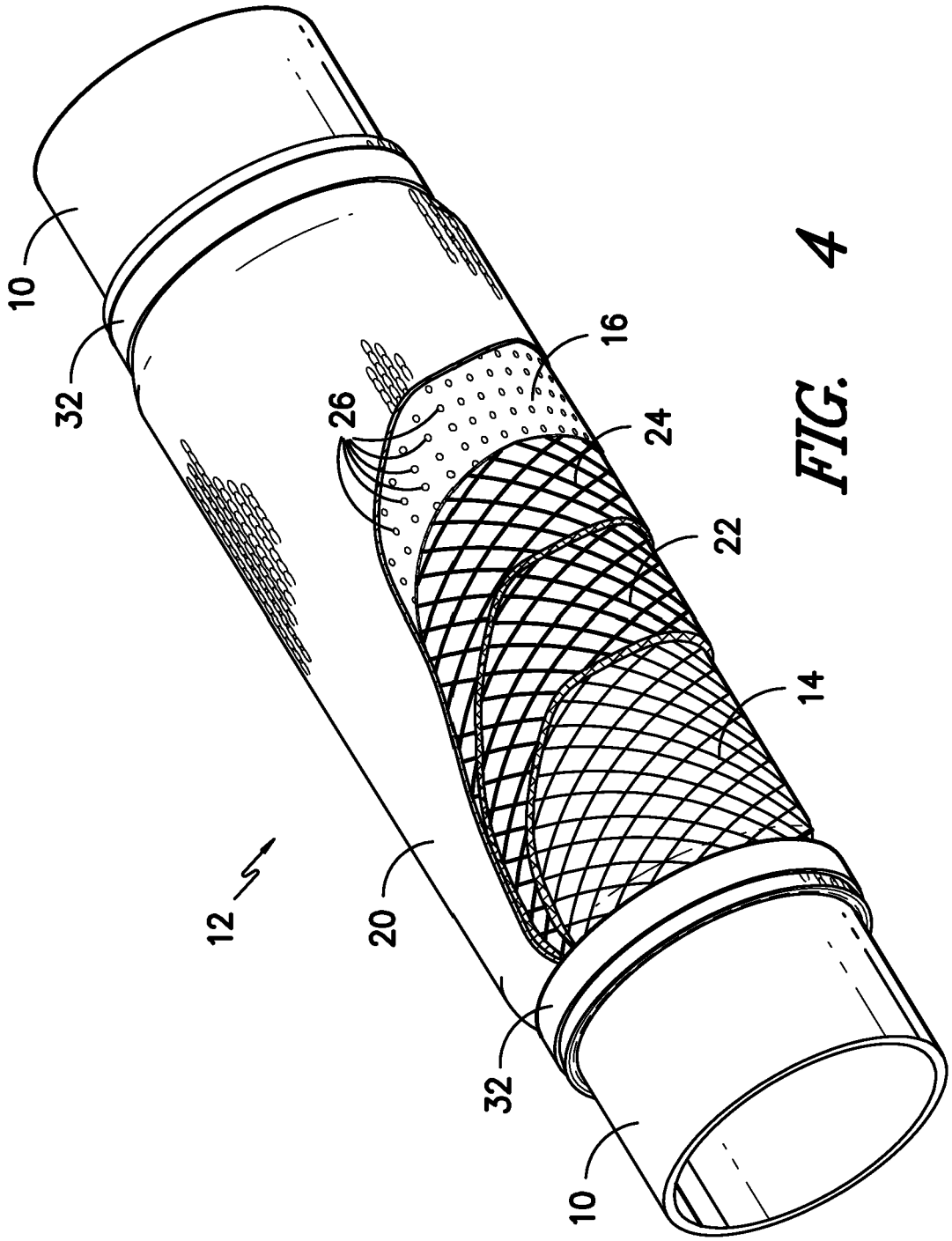


FIG. 4

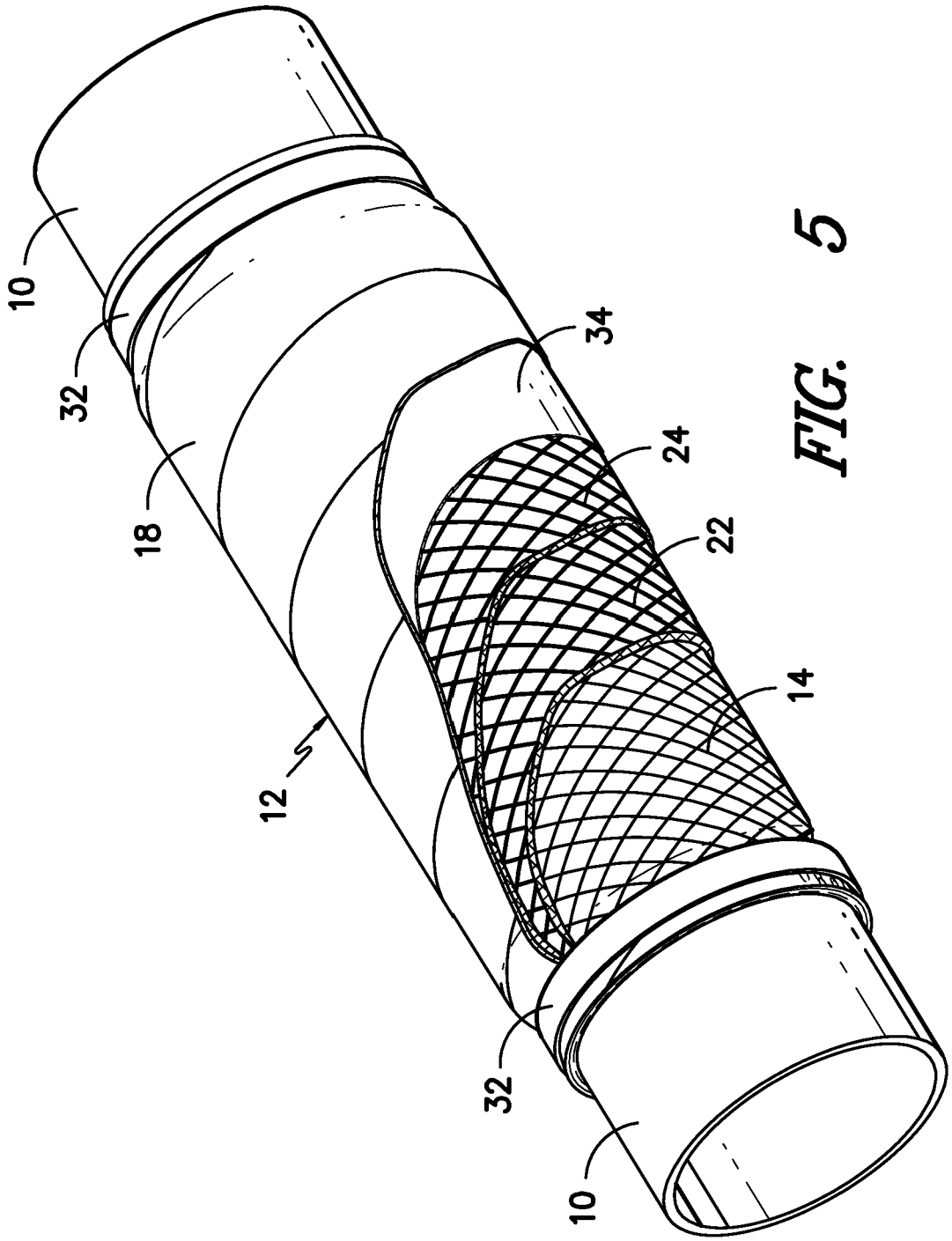


FIG. 5

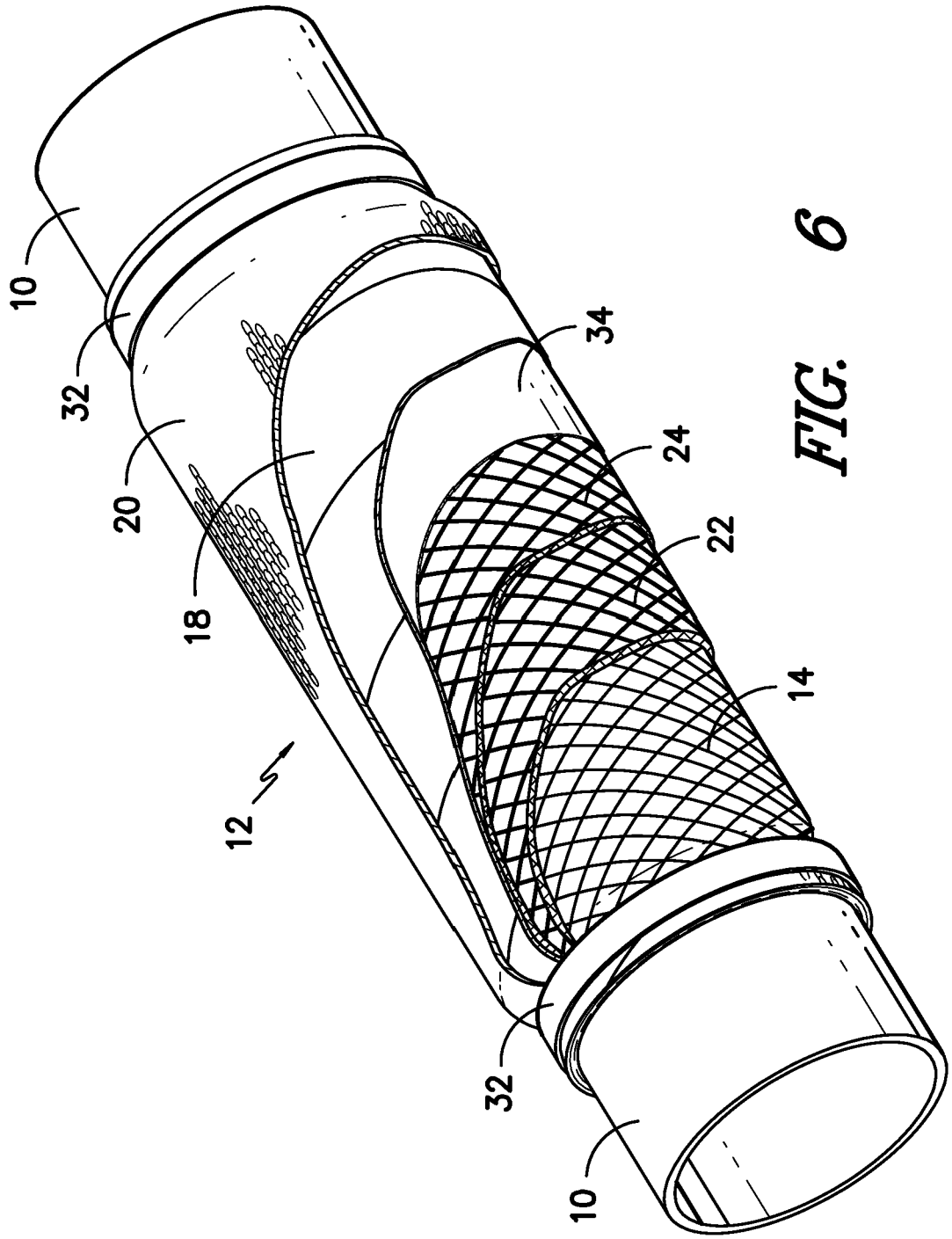


FIG. 6

BREATHABLE MULTI-COMPONENT EXHAUST INSULATION SYSTEM

CROSS-REFERENCE TO PRIORITY APPLICATION

This application is a continuation of U.S. patent application Ser. No. 15/985,135 filed on May 21, 2018, now U.S. Pat. No. 10,295,109, which itself is a continuation of U.S. patent application Ser. No. 13/475,501 filed on May 18, 2012, now U.S. Pat. No. 9,976,687, both for a "BREATHABLE MULTI-COMPONENT EXHAUST INSULATION SYSTEM," and both of which are hereby incorporated by reference in their entirety.

BACKGROUND OF THE INVENTION

The present invention relates generally to insulation for exhaust systems and other types of pipe systems that transport hot gases and other hot fluid materials. More specifically, the present invention relates to a multi-component sleeve that may be used, among other things, to fit exhaust systems on vehicles generally and large trucks in particular.

Heretofore, various insulation systems have been used to insulate automotive and industrial exhaust systems. Exhaust insulation systems are used to maintain high temperature of exhaust gases in order to provide more efficient and complete combustion of fuels, and to protect surrounding components from the high exhaust temperatures. Additionally, maintaining high exhaust temperatures tends to increase the velocity of the exhaust gases through the system, which allows the engine cylinder to more fully evacuate and aids in the emission control processes. On large bore diesel trucks, insulating the exhaust system has been shown to improve the performance of the emission control system located in the exhaust stream system.

U.S. Pat. No. 6,610,928 discloses a sleeve for providing thermal insulation to elongated substrates, formed from a composite sheet having a tough, resilient reinforcing layer to which a metallic reflective layer is attached on one side and a fibrous, non-woven insulative layer is attached on the opposed side. The sleeve includes a seam, formed lengthwise along the sleeve in spaced relation to the reverse fold, defining a central space for receiving elongated substrates.

U.S. Pat. No. 6,978,643 is directed to a multilayer sleeve for insulating or protecting elongated substrates, wherein the sleeve is continuously knitted in different sections integrally joined end to end, the sections being formed of different filamentary members chosen for desired characteristics. The sleeves are formed into the multilayer configuration by reverse folding the sleeves inwardly to place one section coaxially within another.

U.S. Pat. No. 5,134,846 discloses a cover for insulating exhaust systems of internal combustion engines comprising a tubular shaped layer of insulating material circumscribingly engaging the exhaust system and a flexible metal sleeve for protecting the insulating material and holding the insulating material against the exhaust system. The cover is held in place by hose clamps or tie wraps.

U.S. Pat. No. 5,092,122 is directed to a means and method for insulating automotive exhaust pipes by sliding a flexible insulated tube over the exhaust pipe. The tube comprises concentrically arranged inner and outer corrugated stainless steel tubes, with the annulus between the corrugated tubes filled with refractory fiber insulation.

U.S. Pat. No. 5,617,900 includes a thermally insulative sleeve with a seamless, hollow flexibly resilient inner tubular member woven of strand material including at least one metal wire strand, a separate, integral, at least essentially unbroken, metal surface member applied over the inner tubular member extending along and at least essentially completely surrounding the inner tubular member and a flexible outer cover also woven of strand material extending along and completely around the inner tubular member and metal surfaced member securing the metal surface member with the inner tubular member and offering some degree of protection. The inner tubular member may be knit from wire or from a combination of wire and glass fiber yarn, the latter providing some thermal insulative protection.

U.S. Patent Application Publication No. 2002/0168488 discloses a protective sleeve for covering elongated substrates, wherein the sleeve is knitted from a combination of first and second filamentary fibers having different properties from one another. The filamentary members are plated so that the filamentary members with properties compatible with the substrate are positioned predominantly on the inner surface of the sleeve facing and engaging the substrate. Filament properties include heat resistance, high tensile strength, resistance to abrasion, chemical attack and damping capability. The sleeve includes ribs integrally knitted lengthwise along the sleeve to form insulating air pockets, and the ends of the sleeve are finished with welts to prevent unraveling.

Unfortunately, many of these prior art exhaust insulation sleeves suffer from various drawbacks. Some are expensive to manufacture and difficult to install on exhaust systems. Some require specialized tooling for each distinct pipe geometry. Many do not provide sufficient breathability, so that when the insulation is exposed to water and rain, the water soaks into the insulation and does not dry quickly, which leads to rust and corrosion within the exhaust system. Because these type systems are subject to large temperature fluctuations, sometimes more than a 1000° F., from start-up to upper operating temperatures and fluctuations within operating temperatures, there is a need for insulating systems to breathe to some degree. Further, particularly in colder climates and coastal climates, salt from the roads can infiltrate the insulation system and accelerate corrosion of the system. Moreover, many of the insulation sleeves and systems are made from materials that do not maintain their structural integrity over time due to wear and tear, and further degrade from the exposure to high temperatures associate with exhaust systems. Therefore, it would be desirable to provide a breathable, tough, resilient insulating system that can withstand the rigors of exposure to high temperatures, salt, water, and general wear and tear, which is inexpensive and easy to manufacture and install.

BRIEF SUMMARY OF THE INVENTION

In accordance with one aspect of the invention, a breathable, multi-layer exhaust insulation system is provided. In one aspect of the invention, the system includes a multi-layer sleeve, wherein the first layer, which is positioned adjacent the exhaust system pipes, is a braided, knit or woven sleeve which may be constructed from high-temperature resistant materials such as e-glass, s-glass, silica or ceramic. Additional braided layers of material may be included, as well. An outside cover of material may be a circular knitted fabric that contains glass fibers, reinforcing fibers and resin-based fibers. The knitted fabric forms a tube on the outside of the insulating layers, which is made by knitting the tube or knitting a fabric and cutting and sewing the tube. The knitted tube may be formed from a core spun

yarn, which includes a glass filament core and a high-melt fiber on the wrap along with stainless steel reinforcing fibers. The wrap can be made from resin type fibers including Poly(p-phenylene sulfide) PPS (sold under the trade name Ryton), Polyetherimide (PEI) sold under the trade name Ultem, Polyether ether ketone (PEEK), Polysulfone (PES), Polyphthalamide (PPA), nylon, polyester, or polypropylene.

Optionally, a metal foil layer (or multiple metal foil layers) may be disposed between the braided insulation and the knit cover to improve insulation performance and reduce the rate of fluid adsorption into the insulation layers. The metal foil layer(s) may be made of aluminum, fiberglass reinforced aluminum, stainless steel, nickel, copper or tin, although any suitable metal foil may be used. Additionally, the metal foil layer(s) may be perforated or unperforated. The perforations enhance breathability of the insulating sleeve.

In one preferred embodiment of the present invention, the insulating sleeve includes a first layer of a braided silica sleeve adjacent the exhaust system pipes, then two layers of braided e-glass for insulation, and an outer layer of a PPS/glass cover treated with a fluorocarbon sewn into a tubular sleeve using a glass/stainless steel sewing thread and a safety lock stitch. Each end of the insulation is secured using a stainless steel band clamp or other suitable attachment means.

Additionally, it may be desirable to include a high-temperature film, which is disposed about an outer side of the metal foil layer, in order to protect the metal foil layer from oxidation. Suitable high-temperature films may include polyimide (commonly referred to as "PI," and commercially available under the trade name Kapton), PEI, PPS, PEEK, PPA, silicone, nylon, polyester or polypropolene.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the present invention will become better understood with regard to the following description, appended claims, and accompanying drawings where:

FIG. **1** is a perspective view of one embodiment of a breathable multi-component insulation system in accordance with the present invention;

FIG. **2** is a perspective cut-away view of one embodiment of a breathable multi-component insulation system in accordance with the present invention;

FIG. **3** is a perspective cut-away view of another embodiment of a breathable multi-component insulation system in accordance with the present invention;

FIG. **4** is a perspective cut-away view of another embodiment of a breathable multi-component insulation system in accordance with the present invention;

FIG. **5** is a perspective cut-away view of another embodiment of a breathable multi-component insulation system in accordance with the present invention; and

FIG. **6** is a perspective cut-away view of another embodiment of a breathable multi-component insulation system in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention includes, in a first embodiment, a breathable, multi-layer exhaust insulation system, as shown in FIGS. **1-6**. The exhaust insulation system includes a multi-layer sleeve **12**, which can take one of several forms, and include a variety of components. The exhaust insulation system sleeve **12** is positioned about an outer side of a pipe **10**, or the like.

Component Layers

The inner layer **14** or layers of the sleeve may include a braided or knit material made from high-temperature resistant materials including, but not limited to e-glass, s-glass, silica or ceramic. Braiding is the preferred textile construction of the inner layer, due to the fact that it is possible to deliver thicker profiles than knitted materials. In one preferred embodiment, the inner layer of silica is about 1/16" thick and the glass layers are 0.2 inches thick. Further, another advantage of using braided material is that stretching the braided layer along the length of the exhaust pipe upon installation tends to tighten the braided layer down around the pipe **10** or underlying layer along the straight and bent sections. Depending upon the application and specification of the desired insulating sleeve **12**, a single braided layer may be used, or multiple braided layers may be used. Additionally, the inner layer **14** of the sleeve **12**, which comes into contact with the underlying exhaust pipe **10**, is preferably made from this braided layer, although other textile constructions may be used, as desired.

Optionally, a metal foil layer **16** may be disposed on the outside of the braided layer(s), as shown in FIGS. **3** and **4**. The metal foil may include perforations **26**, as shown in FIG. **4**, in order to enhance breathability of the sleeve **12**, which facilitates drying of the sleeve **12** after exposure to water or other liquid. The metal foil layer **16** may be formed from aluminum, fiberglass reinforced aluminum, stainless steel, nickel, copper or tin, although it should be understood that any other suitable metal foil may be used, if such a layer is desired. The metal foil layer **16** serves to improve the insulation performance of the insulation sleeve **12** and to reduce the rate of fluid adsorption into the insulation layers. Additionally, it may be desirable to include a high-temperature film, which is disposed about an outer side of the metal foil layer **16**, in order to protect the metal foil layer **16** from oxidation. Suitable high-temperature films may include polyimide (PI) (commercially available under the trade name Kapton), PEI, PPS, PEEK, PPA, silicone, nylon, polyester or polypropolene. Optionally, a tape wrap **18** may be wrapped around the metal foil layer **16**, as shown in FIG. **5**, primarily to prevent salt and other corrosive materials from penetrating through the insulative sleeve. One example of a tape wrap **18** is sold by DuPont, under the tradename of KAPTON™.

An outer cover layer **20** is preferably a knitted tube that fits around the other, underlying layers. Generally, the outer cover layer **20** comprises a knitted fabric that includes glass fibers and resin-based fibers. Thermoplastic fibers may include polyester, nylon, PPS or ULTEM™. The outer cover layer **20** knitted tube is preferably made from a core spun yarn, which includes a glass filament core and a high melt fiber wrapped around the glass filament core further twisted with a stainless steel yarn. The wrap may be made from PPS (Ryton). The outer cover layer **20** knitted tube may be disposed on the outside of the underlying insulating layers by knitting the tube around the underlying layers, or by knitting the tube and cutting and sewing the outer cover layer **20** knitted tube around the underlying layers of the sleeve. Additionally, the outer cover layer **20** may be treated with a fluorocarbon, such as Zonyl from Dupont, in order to reduce the penetration of fluids into the cover and the overall system.

Preferred Construction

In one preferred embodiment, the inner layer **14** adjacent the exhaust pipe **10** is a braided silica sleeve. The next two layers **22**, **24** outside of the inner braided silica layer are each preferably formed from braided e-glass for insulation. The outer cover layer **20** is a 3-dimensional, spacer fabric in which a single fabric is comprised of three layers or portions, an inner portion, middle portion and outer portion. The outer portion preferably includes PPS/glass and stainless steel yarn. The inner portion is preferably made from glass fibers and the middle portion is made from PPS/glass/stainless steel yarns. The outer cover layer **20** may be treated with a fluorocarbon, and may be sewn into a tubular sleeve, preferably by using a glass/stainless steel sewing thread and a safety lock stitch. Stainless steel band clamps **32** are the preferred means for affixing the exhaust insulation sleeve **12** to the pipe **10**, although other attachment means may be used.

Alternatively, another preferred embodiment includes a layer of fiberglass reinforced aluminum **34** disposed between the outer cover layer **20** and the underlying braided e-glass layer **24**. Additionally, this layer of fiberglass reinforced aluminum may include a series of perforations throughout that layer, in order to enhance the breathability of the sleeve. One other alternative embodiment includes the use of a tape wrap **18**, such as the prior-mentioned DuPont product KAPTON™, which is wrapped around the outside of the fiberglass reinforced aluminum layer set forth above, as shown in FIGS. **5** and **6**.

Installation

To install the sleeve **12** on a section of exhaust pipe **10**, the layers are added by sliding the inner layer **14** onto the pipe, then sliding the next layer **22** over the underlying layer **14**, and continuing in this fashion until the only remaining layer to install is the outer cover layer **20**. For the underlying braided layers, an installer may optionally stretch them along the length of the section of pipe **10** in order to tighten them down to the pipe **20** or underlying layers. The outer cover layer **20** may then be slipped over the underlying layers. The system can also be preassembled and then slipped onto the pipe **10** as a single component. The outer cover layer **20** may be knitted and finished as a flat fabric and then cut and sewn into the correctly sized tube. The outer layer **20** may also be knit to the correct size diameter and used in this form. Then the clamps **32** are applied to each end of the sleeve **12**, in order to secure it to the pipe **10**, and the entire apparatus is placed into an oven, preferably at about 560° F. for one hour, for curing. The outer layer **20** becomes dimensionally stable and significantly stiffer as a result of the yarns fusing together and more durable after curing, although the entire system remains breathable.

Although the present invention has been described in considerable detail with reference to certain preferred versions thereof, other versions are possible. Therefore, the spirit and scope of the appended claims should not be limited to the description of the preferred versions contained herein. All features disclosed in this specification may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention claimed is:

1. A breathable, multi-component exhaust insulation sleeve for an exhaust pipe, said insulation sleeve comprising:

an inner layer comprising a first fabric made from a first high-temperature resistant material forming a sleeve, wherein said sleeve is configured to be positioned adjacent to and disposed about an outer surface of a section of the exhaust pipe; and

an outer cover layer comprising heat cured polymeric resin and a second fabric including yarns comprising glass fibers, wherein the outer cover layer is positioned adjacent to and disposed over the inner layer, wherein the yarns are fused together, wherein the fused yarns dimensionally stabilize and stiffen the outer cover layer around the inner layer.

2. The insulation sleeve set forth in claim **1**, wherein said inner layer is made from material selected from the group consisting of e-glass, s-glass, silica, basalt and ceramic.

3. The insulation sleeve set forth in claim **1**, wherein said outer cover layer is made from a core spun yarn having a glass filament core and a thermoplastic fiber wrapped around said glass filament core.

4. The insulation sleeve set forth in claim **3**, wherein said thermoplastic fiber is selected from the group consisting of Poly(p-phenylene sulfide), Polyetherimide, Polyether ether ketone, Polysulfone, Polyphthalamide, nylon, polyester, and polypropylene.

5. The insulation sleeve set forth in claim **1**, further including at least one middle layer disposed between said inner layer and said outer layer.

6. The insulation sleeve set forth in claim **5**, wherein said middle layer is a metal foil layer.

7. The insulation sleeve set forth in claim **6**, wherein said metal foil layer includes a series of perforations.

8. The insulation sleeve set forth in claim **6**, wherein said metal foil layer is made from a material selected from the group consisting of aluminum, fiberglass reinforced aluminum, stainless steel, nickel, copper and tin.

9. The insulation sleeve set forth in claim **6**, wherein said metal foil layer is over-wrapped with a high-temperature tape made from materials selected from the group consisting of fiberglass, PPS, PEI, PI, PPA, nylon, polyester and polypropylene.

10. The insulation sleeve set forth in claim **6**, wherein said metal foil layer includes a film disposed on at least one side of said metal foil layer, wherein said film is manufactured from material selected from the group consisting of Poly(p-phenylene sulfide), Polyetherimide, Polyether ether ketone, Polysulfone, Polyphthalamide, nylon, polyester and polypropylene.

11. The insulation sleeve set forth in claim **1**, wherein said outer cover layer is treated with a fluorocarbon.

12. The insulation sleeve set forth in claim **1**, wherein said inner layer is formed from braided silica, and wherein said sleeve further comprises at least one layer of braided fabric including e-glass fibers.

13. The insulation sleeve set forth in claim **12**, wherein said outer cover layer is formed from PPS/glass fibers.

14. The insulation sleeve set forth in claim **13**, wherein said outer cover layer is sewn into a tubular sleeve using a high temperature sewing thread made from material selected from the group consisting of glass/stainless steel, meta aramid and para-aramid.

15. The insulation sleeve set forth in claim **14**, wherein said outer cover layer is sewn into said tubular sleeve with a safety lock stitch.

16. The insulation sleeve set forth in claim **12**, further including a second layer of said braided e-glass fibers, which is disposed about the outside of said at least one layer of said braided e-glass fibers.

17. The insulation sleeve set forth in claim **16**, further including a metal foil layer disposed about the outer surface of said second layer of said braided e-glass fibers.

18. The insulation sleeve set forth in claim **17**, wherein said metal foil layer comprises fiberglass reinforced aluminum.

19. The insulation sleeve set forth in claim **18**, wherein said metal foil layer includes a series of perforations.

20. The insulation sleeve set forth in claim **17**, further including a tape wrap disposed about an outer surface of said metal foil layer.

* * * * *

Exhibit 2

LINCOLN INDUSTRIES / INNOVATION INSPIRED.®

THERMOLINC® ELITE

DESCRIPTION

Lincoln Industries ThermoLinc® Elite is a multilayer textile solution that solves a variety of heat management challenges in both diesel and gas exhaust engines. Performing up to 950°C (1742°F), Elite is able to conform to complex geometries and offers significant surface temperature reduction.

A current motorsports exhaust header application showed an insulated surface temperature well below 150°C at approximately 927°C exhaust gas temp (EGT). This versatile, cost effective and high performing heat management technology is ready for use in many exhaust applications.

INDUSTRIES

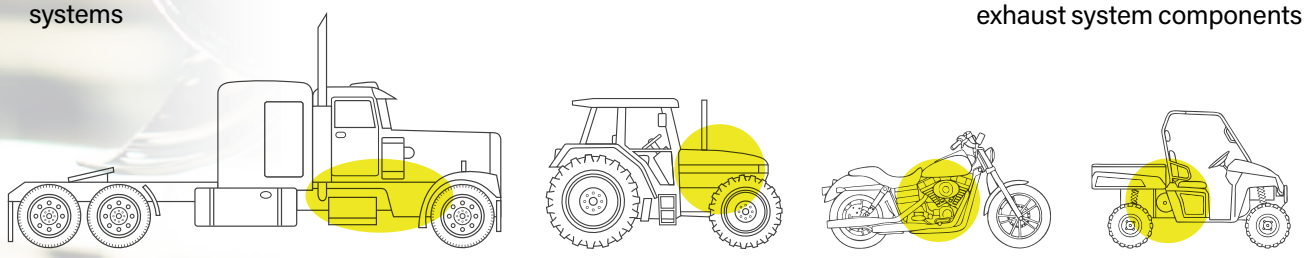
- Agriculture
- Heavy truck
- Marine
- Motorcycle
- Rail
- UTV/ATV
- Power generation

PRODUCT BENEFITS

- Performs up to 950°C EGT
- Conforms to complex geometries
- Minimal tooling investment
- Textile cover provides durable outer layer
- High degree of thermal and performance flexibility

APPLICATION EXAMPLES

- Exhaust after-treatment systems
- Fire mitigation
- Rider comfort
- Protects neighboring exhaust system components



PREMIUM PROVEN QUALITY SOLUTIONS

THERMOLINC® ELITE

TESTING MATRIX

ATTRIBUTE	VALUE	SAMPLE TESTED	STANDARD
Thermal Conductivity	0.06 W/m/k at 260°C, 0.133 at 538°C, 0.244 at 816°C, 0.327 at 982°C	Fiber mat insulation (uncompressed)	ASTM C1114
Appearance	Uniform cover-multiple tinting options available	Black cover and insulation on 4" diameter pipe	Lincoln Industries' Standard
Vertical Burn Test	Cover did not ignite or propagate, loss of cover resin and compression layer	Tinted (black) cover and insulation on a 4" diameter pipe, heat aged for 48 hours at 260°C min.	Lincoln Industries' Standard: Direct flame (MAPP) 2000°C for 60 seconds
Gravelometer	Passed - Softening of the cover, some resin loss, no holes formed in cover	Tinted (black) thermoset glass braid cover and insulation on a 4" diameter pipe, heat aged for 48 hours at 260°C min.	SAE J400, repeat 100 cycles
Drop Impact	Passed – No external damage	Tinted (black) thermoset glass braid cover and insulation on a 4" diameter pipe, heat aged for 48 hours at 260°C min.	ASTM D-2794 modified
Cold Cracking	No visual degradation	Tinted (black) thermoset glass braid cover and insulation on a 4" diameter pipe, heat aged for 48 hours at 260°C min.	Lincoln Industries' Standard: Dry Ice (-78°C) for 2 hours, 260°C for 2 hours, repeat 10x
High Pressure Wash Adhesion	No visual degradation	Tinted (black) thermoset glass braid cover and insulation on a 4" diameter pipe, heat aged for 48 hours at 260°C min.	STD 423-0015 modified
Vibration	No visual degradation	Tinted (black) thermoset glass braid cover and insulation on a 4" diameter pipe, heat aged for 48 hours at 260°C min.	Lincoln Industries' Standard: Immerse in water 1hr, install on vibe table 24hr, repeat 4X. Equipment: Vibco 4P-100, 24"x24" Vibration Table, 1800 vpm, 0.071" displacement, 3.4G's, 30 Hz.
Neutral Salt Spray	Passed – No visual degradation to insulation cover	Tinted (black) thermoset glass braid cover and insulation on a 4" diameter pipe, heat aged for 48 hours at 260°C min.	ASTM B-117, 96 hour
Chemical Resistance	Passed - No visual degradation to sample material coupons	Thermoset glass impregnated textile samples, natural color	Lincoln Industries' Standard: 240 hour chemical immersion (see table below)

CHEMICAL RESISTANCE TESTING

CHEMICAL TESTED	PASSED CHEMICAL IMMERSION AT 240 HRS	CHEMICAL TESTED	PASSED CHEMICAL IMMERSION AT 240 HRS
Antifreeze (50/50)	X	Diesel Fuel	X
Antifreeze (extended life)	X	Gasoline	X
Antigel	X	Heat	X
ATF	X	Metal Polish (Aluminum Polish)	X
Water	X	Metal Polish (Chrome Polish)	X
Brake Fluid	X	Motor Oil	X
Brake Fluid (synthetic)	X	Motor Oil (synthetic)	X
Dawn Soap	X	Water	X
DEF	X	Windshield Wiper Fluid	X